GROUP 13B

MULTIPOINT FUEL INJECTION (MPI) <4G1>

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GENERAL INFORMATION

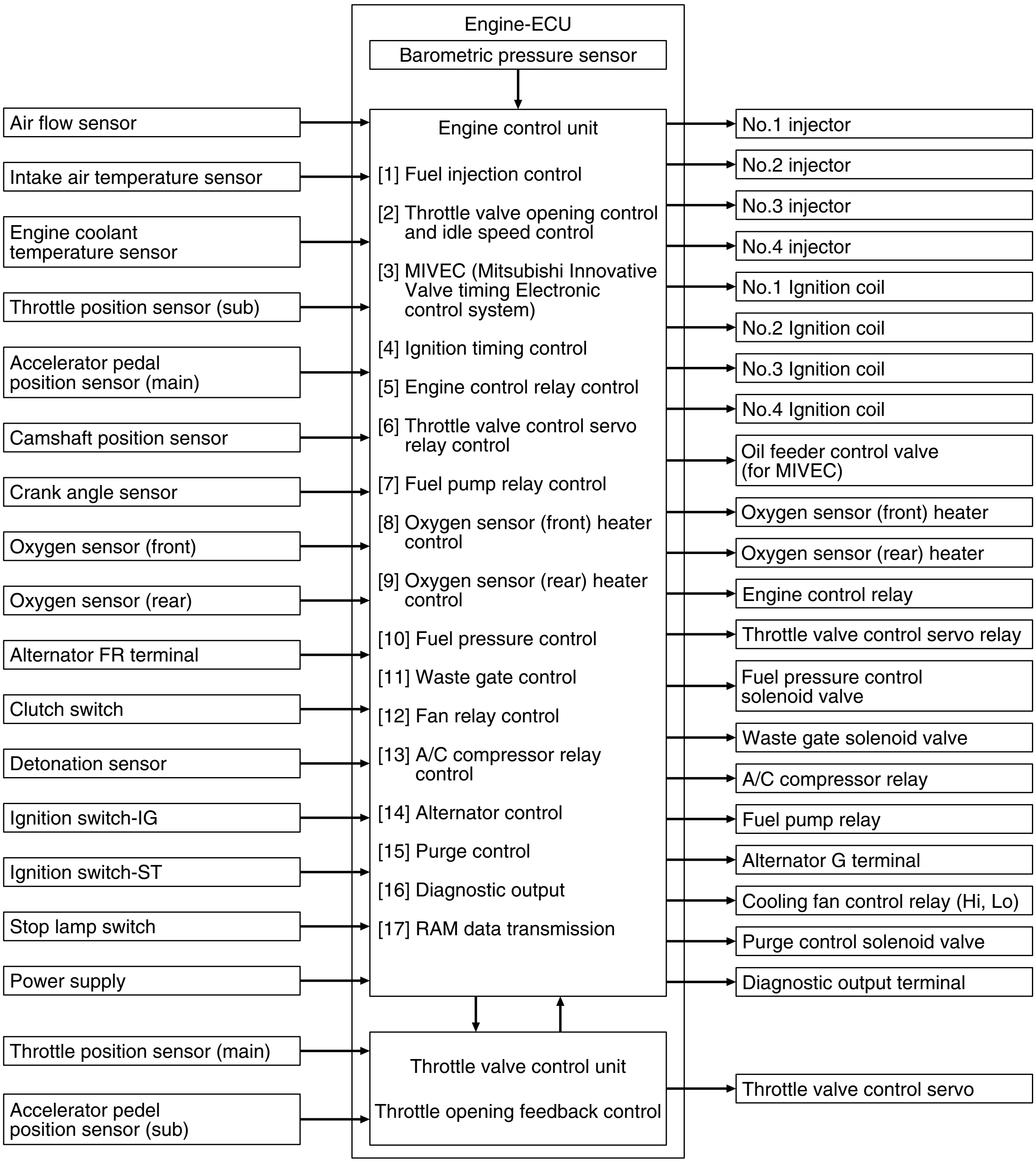
M2132000101001

Although the control systems are basically the same as those of the 4G1-Non-Turbo engine used in the COLT, the following improvements have been added.

Improvement	Remark
A heat-sensing type air flow sensor is used.	• Changed to the intake air flow measurement system by the air flow sensor. • The sensor is basically the same as that of the 4G69-MPI engine used in the GRANDIS.
Supercharging pressure control system is used.	Controls the boost pressure that affects the waste gate actuator in response to the signals from the engine-ECU.
Fuel pressure control solenoid valve is used.	Idling stability immediately after restarting the engine at high temperature is maintained.
Dual oxygen sensor is used.	Higher reliability of air-fuel ratio control.
Clutch switch is used.	The information about whether the clutch pedal is depressed or not is input into the engine-ECU.

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SYSTEM BLOCK DIAGRAM

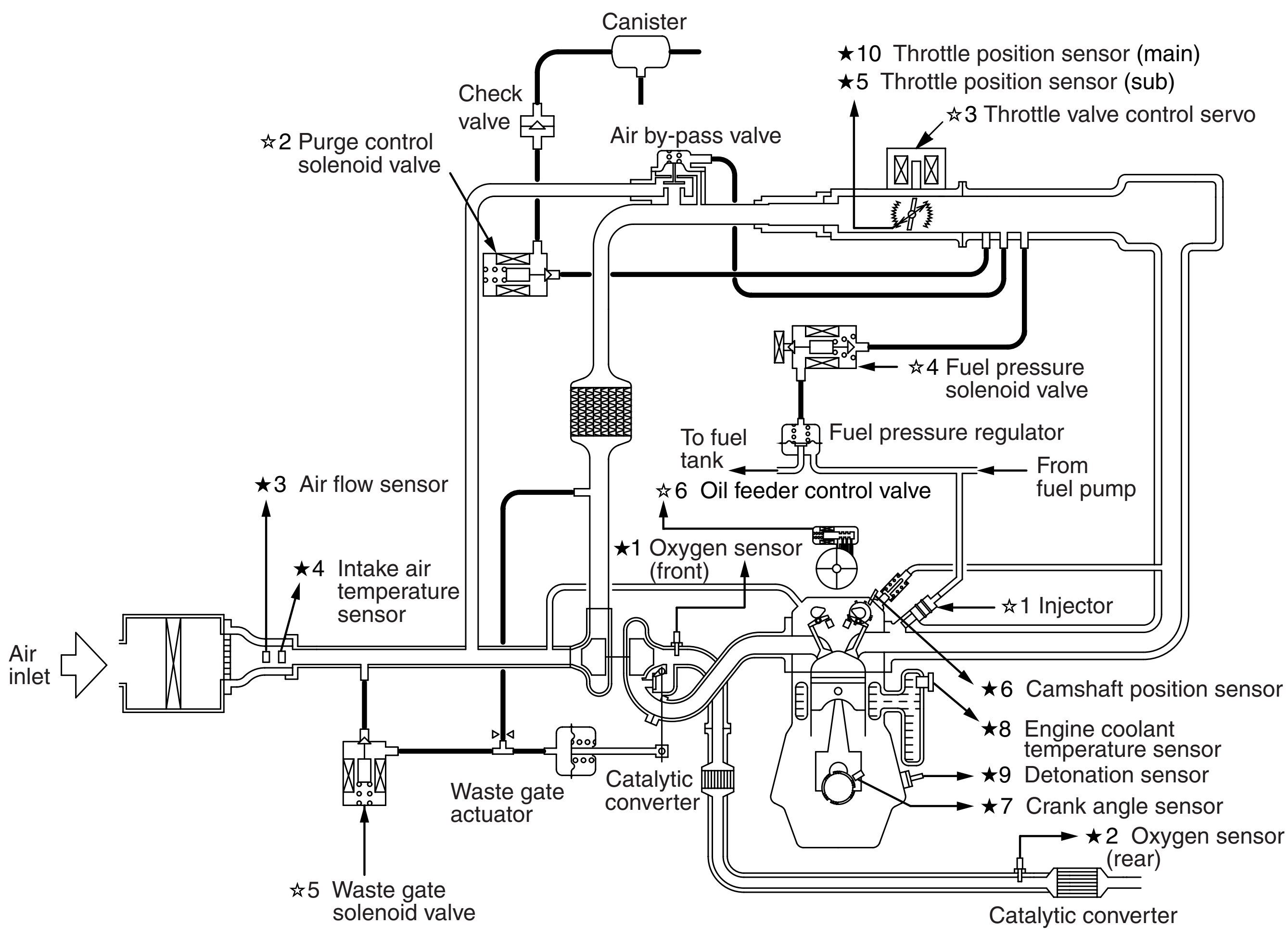


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CONTROL SYSTEM DIAGRAM

Sensors	Switches / signals		Engine-ECU		Actuators	Relays / outputs
★ 1 Oxygen sensor (front) ★ 2 Oxygen sensor (rear) ★ 3 Air flow sensor ★ 4 Intake air temperature sensor ★ 5 Throttle position sensor (sub) ★ 6 Camshaft position sensor ★ 7 Crank angle sensor ★ 8 Engine coolant temperature sensor ★ 9 Detonation sensor ★10 Throttle position sensor (main)	● Power supply ● Ignition switch-IG ● Ignition switch-ST ● Accelerator pedal position sensor (main) ● Accelerator pedal position sensor (sub) ● Alternator FR terminal ● Stop lamp switch ● Clutch switch	⇨	Engine-ECU ●Barometric pressure sensor	⇨	☆ 1 Injector ☆ 2 Purge control solenoid valve ☆ 3 Throttle valve control servo ☆ 4 Fuel pressure solenoid valve ☆ 5 Waste gate solenoid valve ☆ 6 Oil feeder control valve	● Engine control relay ● Fuel pump relay ● A/C compressor relay ● Throttle valve control servo relay ● Ignition coil ● Cooling fan control relay (Hi, Lo) ● Diagnosis output ● Alternator G terminal ● Oxygen sensor (front) heater ● Oxygen sensor (rear) heater



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List of Component Functions

ECU	
Name	**Function**
Engine-ECU	The signals that are input by the sensors enable the actuators to be controlled in accordance with the driving conditions.
Sensor	
Ignition switch-IG	This signal indicates the ON/OFF condition of the ignition switch. When this signal is input, the engine-ECU supplies power to the crank angle sensor, camshaft position sensor, etc.
Ignition switch-ST	This signal indicates that the engine is cranking. Based on this signal, the engine-ECU controls the fuel injection, throttle valve position, and the injection timing that are suited for starting the engine.
Air flow sensor	This signal, which indicates the intake air flow rate (mass), is input into the engine-ECU. Based on the signals from this sensor, the engine-ECU effects fuel injection control.
Oxygen sensor <front, rear>	This sensor, which contains zirconia and platinum electrodes, detects the level of oxygen concentration in the exhaust gases. The engine-ECU determines whether the air-fuel ratio is at the optimal stoichiometric ratio in accordance with this oxygen concentration level.
Barometric pressure sensor	This sensor detects the altitude of the vehicle. It enables the engine-ECU to make fuel injection volume corrections in order to achieve an appropriate air-fuel ratio.
Intake air temperature sensor	This sensor, which contains a thermistor, detects the temperature of the intake air. The engine-ECU makes fuel injection volume corrections that suit the intake air temperature, in accordance with the voltage that is output by this sensor.
Engine coolant temperature sensor	This sensor, which contains a thermistor, detects the temperature of the engine coolant. The engine-ECU determines the warm-up condition of the engine in accordance with the voltage that is output by this sensor, in order to control the fuel injection volume, idle speed, and ignition timing.
Throttle position sensor <main, sub>	This sensor detects the position of the throttle valve and inputs it into the engine-ECU. Based on the voltage that is output by this sensor, the engine-ECU effects throttle valve feedback control.
Accelerator pedal position sensor <main, sub>	This sensor detects the position of the accelerator and inputs it into the engine-ECU. Based on the voltage that is output by this sensor, which determines the accelerator position (and the intention of the driver), the engine-ECU effects appropriate fuel injection and throttle valve position controls.

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ECU	
Name	**Function**
Camshaft position sensor	This sensor detects the top-dead-center (TDC) of the compression stroke of each cylinder.
Crank angle sensor	This sensor detects the crank angle and inputs it into the engine-ECU. The engine-ECU effects injector control and other controls in accordance with the signals received from this sensor.
Detonation sensor	This sensor, which contains a piezoelectric element, detects the vibration of the cylinder block that results from knocking. The engine-ECU detects only the knocking of the engine from these vibrations, in order to retard the ignition timing in accordance with the strength of the knocks.
Alternator FR terminal	This terminal is used for detecting the duty cycle ratio that energizes the alternator field coil.
Stop lamp switch	This is a contact point type switch that detects how the brake pedal is depressed.
Actuators	
Engine control relay	This relay turns ON and OFF the engine-ECU power circuit.
Throttle valve control servo relay	This relay turns ON and OFF the actuation power circuit for the throttle valve control servo in the engine-ECU.
Injector	The injectors inject fuel in accordance with the injection signals received from the engine-ECU.
Ignition coil (with power transistor)	Applies ignition coil primary current intermittently in accordance with the ignition signals received from the engine-ECU, in order to generate high voltage for ignition.
Fuel pump relay	Controls the power supplied to the fuel pump in accordance with the signals received from the engine-ECU.
A/C compressor relay	Controls the operation of the A/C compressor in accordance with the signals received from the engine-ECU.
Purge control solenoid valve	Controls the flow rate of the purge air introduced into the inlet manifold in accordance with the signals received from the engine-ECU.
Alternator G terminal	Controls the amount of current generated by the alternator in accordance with the signals received from the engine-ECU.
Cooling fan control relay	Controls the speed of the cooling fan in accordance with the signals received from the engine-ECU.
Throttle valve control servo	Controls the throttle valve position in accordance with the signals received from the engine-ECU.

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ECU	
Name	**Function**
Oil feeder control valve	The oil feeder control valve, which is actuated by the signals received from the engine-ECU, controls the valve timing.
Oxygen sensor heater <front, rear>	Turns ON and OFF the oxygen sensor heater circuit in accordance with the signals received from the engine-ECU.
Fuel pressure control solenoid valve	Controls the fuel pressure in accordance with the signals received from the engine-ECU.
Waste gate solenoid valve	Controls the boost pressure that affects the waste gate actuator in accordance with signals received from the engine-ECU.

FUEL INJECTION CONTROL

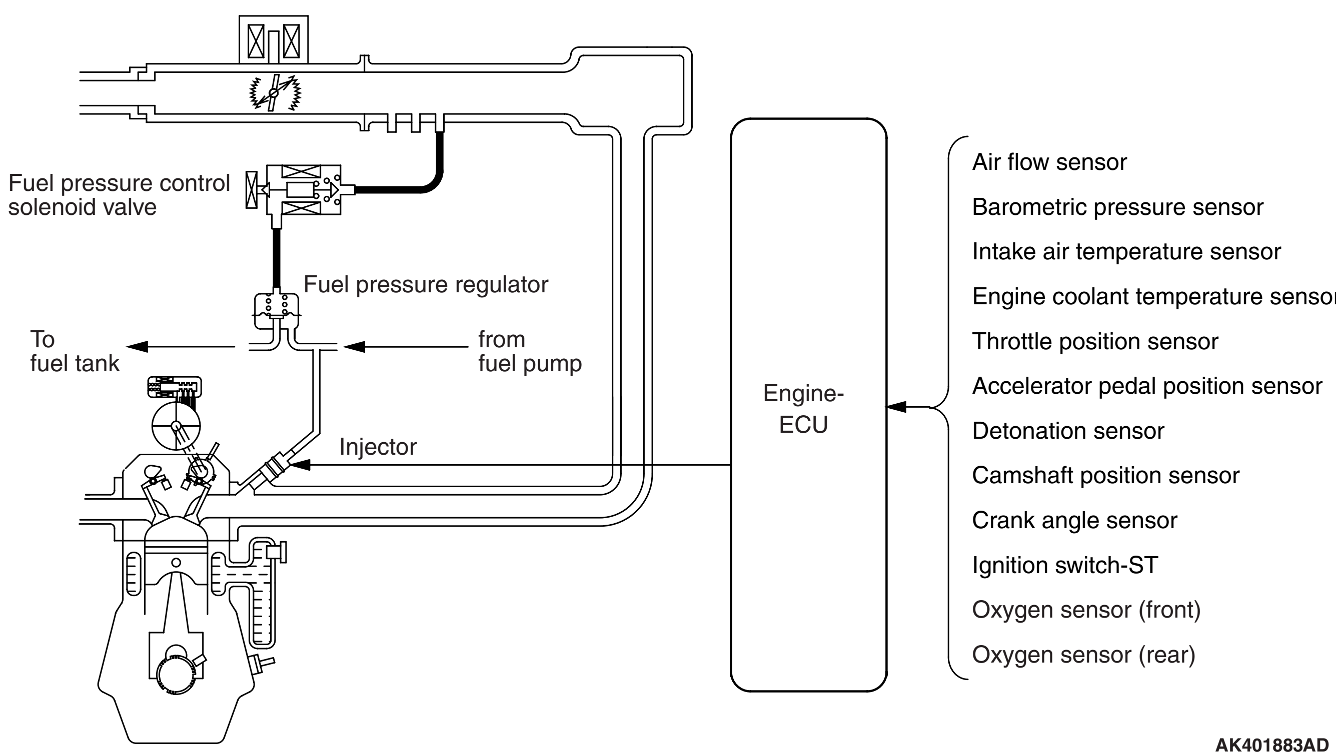
M2132003000851

The following control is basically the same as those of the 4G6-MIVEC engine used in the GRANDIS, the following improvements have been added.

- Fuel pressure control solenoid valve

In accordance with the signal received from the engine-ECU, the fuel is controlled.

System Configuration Diagram



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THROTTLE VALVE OPENING ANGLE CONTROL AND IDLE SPEED CONTROL

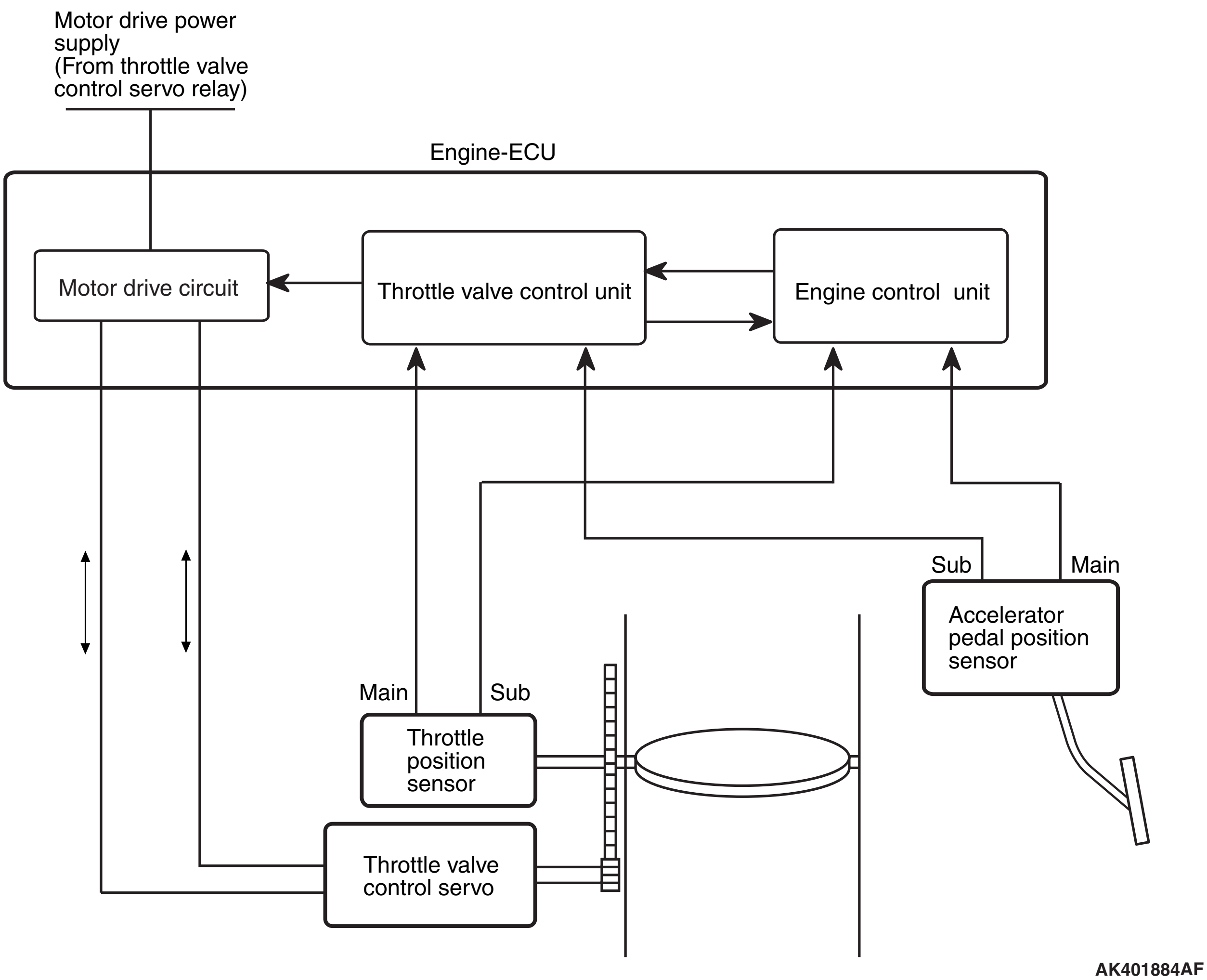
M2132003500209

The following control is basically the same as those of the 4G1-Non-Turbo engine used in the COLT, the following improvements have been added.

- Clutch monitor switch

The clutch monitor switch inputs the signal into the engine-ECU to transmit the information about whether the clutch pedal is depressed or not. By this signal, the engine-ECU identifies the clutch pedal is depressed when the transmission is shifted, and perform the following control. When the clutch pedal is depressed, the throttle valve is automatically closed and the ignition timing is retarded at the same time.

System Configuration Diagram



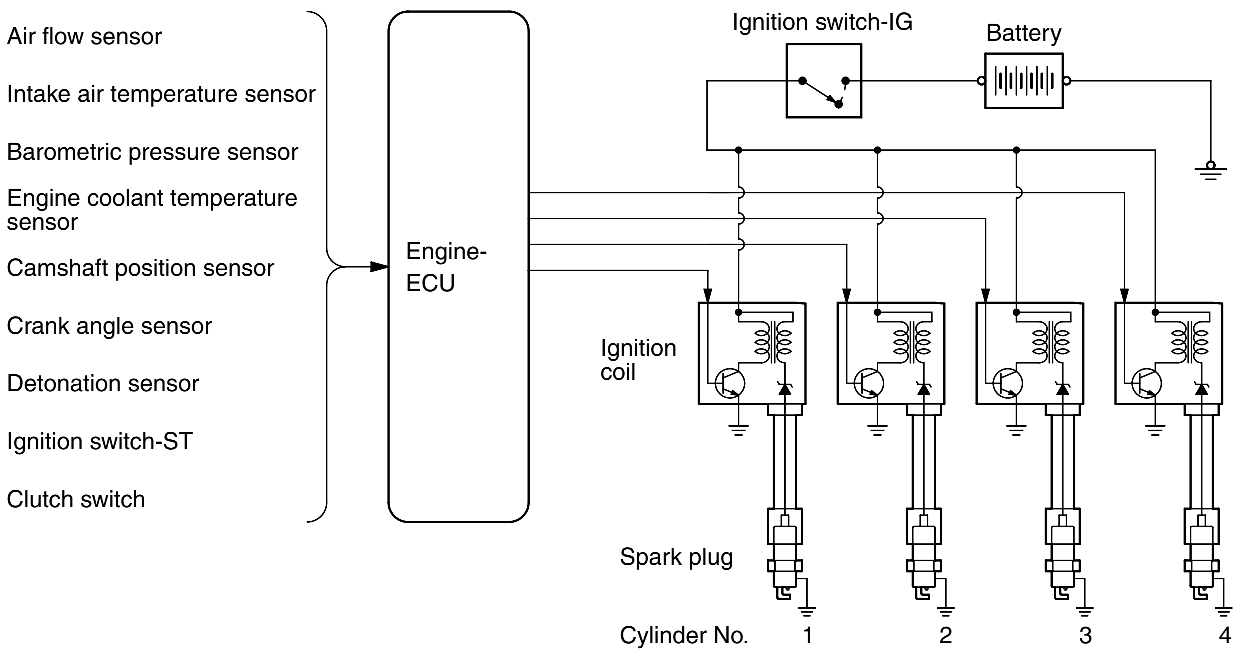
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IGNITION TIMING AND DISTRIBUTION CONTROL

M2132005000761

This control system is basically the same as that of the 4G1-Non-Turbo engine used in the COLT.

System Configuration Diagram



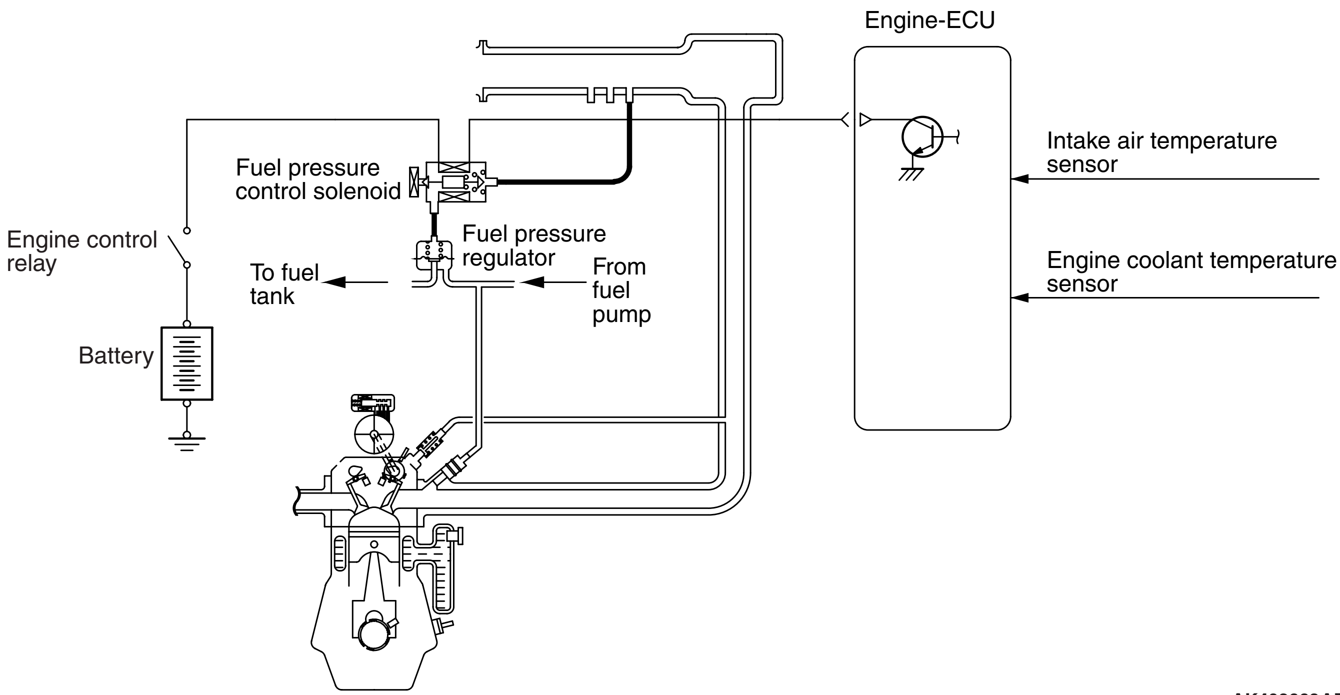
AK402031 AH

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FUEL PRESSURE CONTROL

M2132020000069

Normally, the negative pressure in the intake manifold acts upon the fuel pressure regulator to maintain the fuel pressure at a constant level with regard to the pressure inside the intake manifold, causing the amount of fuel injected to be controlled proportion to the injector drive time. However, if the engine is started while the engine coolant temperature and the intake air temperature are high, the engine-ECU makes current flow to the fuel pressure control solenoid valve to activate the fuel pressure regulator by means of atmospheric pressure. Because of this, the generation of fuel vapour due to the high fuel pressure and high temperature is avoided, and the idling stability immediately after restarting the engine at high temperature is maintained.



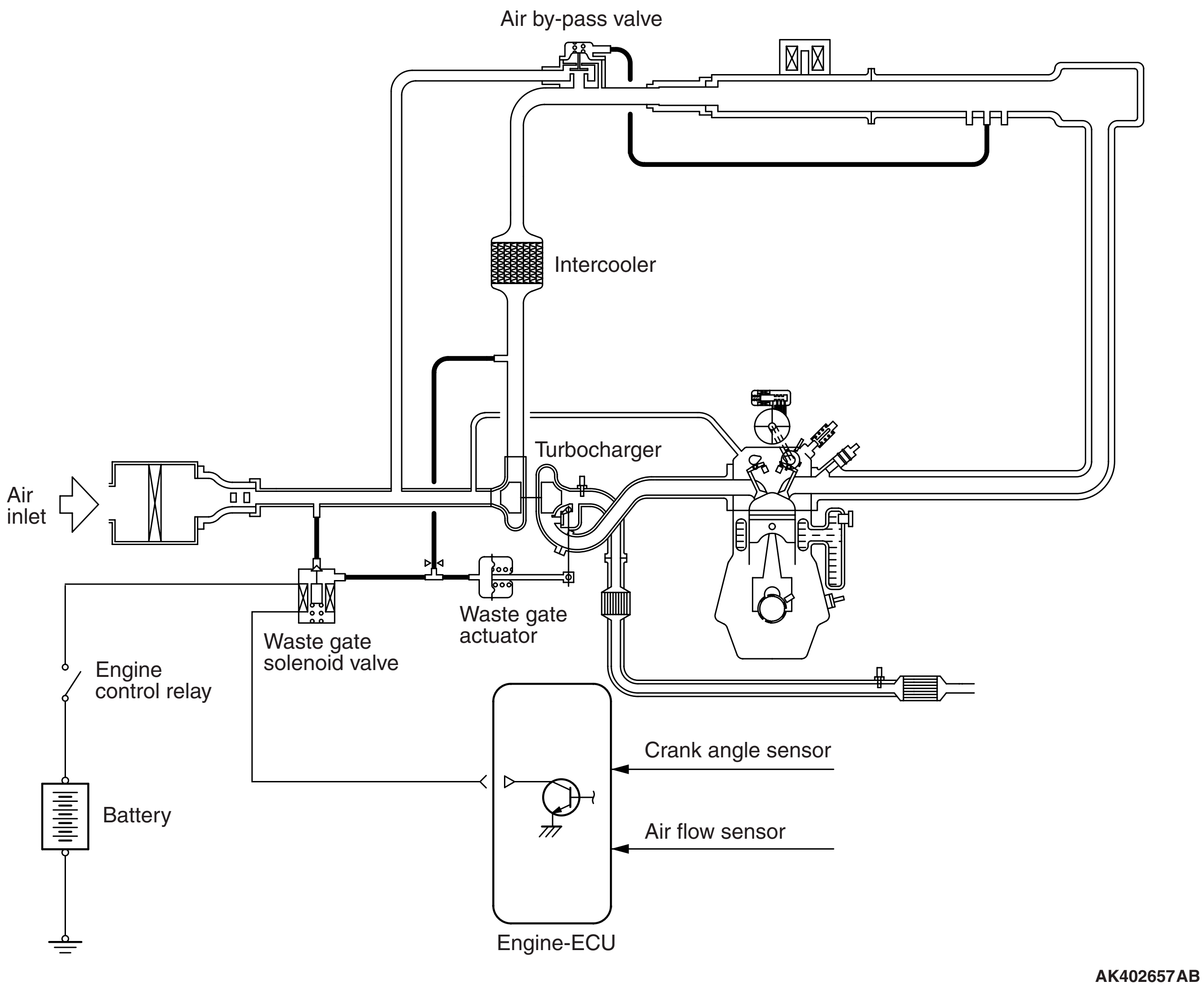
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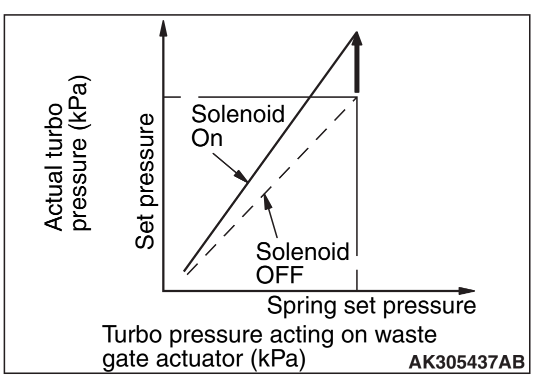
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WASTE GATE CONTROL

M2132013000078

Turbo pressure used in the waste gate actuator is controlled by duty control of the waste gate solenoid valve. As a result, turbo pressure corresponding to driving conditions can be obtained.





The engine-ECU turns the power transistor ON and, when normal current (duty 100%) flows in the waste gate solenoid valve coil, the waste gate solenoid valve does not open if turbo pressure does not rise above the set pressure of the waste gate actuator spring since some of the turbo pressure used in the waste gate actuator leaks out.

On the other hand, when current does not flow in the waste gate solenoid valve coil (duty 0%), the waste gate valve opens if turbo pressure rise to the set pressure of the waste gate actuator spring since no pressure leaks out.

Consequently, by using duty control for the waste gate solenoid valve, turbo pressure can be controlled in a range from 0% to 100% duty. This duty control is performed in cycles of approximately 60ms.

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OTHER CONTROL FUNCTIONS

M2132010000648

The following controls are basically the same as those of the 4G1-Non-Turbo engine used in the COLT.

- ENGINE CONTROL RELAY CONTROL
- THROTTLE VALVE CONTROL SERVO RELAY CONTROL
- MIVEC (Mitsubishi Innovative Valve Timing Electronic Control System)
- FUEL PUMP RELAY CONTROL
- OXYGEN SENSOR (front) HEATER CONTROL
- OXYGEN SENSOR (rear) HEATER CONTROL
- FAN RELAY CONTROL
- A/C RELAY CONTROL
- ALTERNATOR CONTROL

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CONTROLLER AREA NETWORK (CAN)

M2132019000300

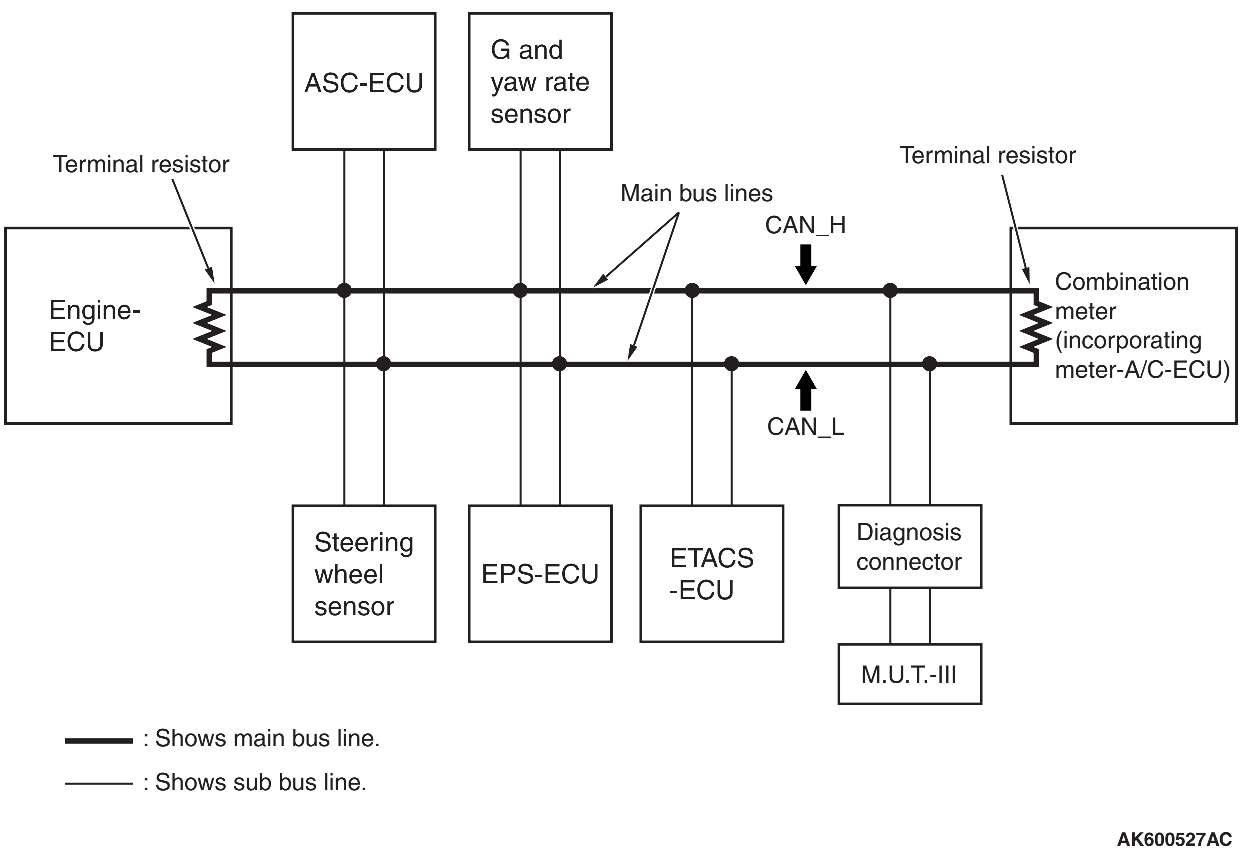
Establishing communication without fail is designed by CAN communication protocol. Refer to Group 54C-CAN P.54C-2 for the details about CAN.

The signals input into engine-ECU are as follows:

CAN Communication Input Signal Table

Input signal name	Transmitter ECU
Motor electric current signal	EPS-ECU
Compressor signal	Meter and A/C-ECU
Idle-up request signal	
Cooling fan request signal	

SYSTEM CONFIGURATION DIAGRAM



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DIAGNOSIS SYSTEM

M2132009000893

Engine-ECU has been provided with the following functions for easier system inspection.

FREEZE-FRAME DATA

When the engine-ECU detects a problem and stores the resulting diagnosis code, the engine condition at that time is also memorized. The M.U.T.-III can then be used to analyze this data in order to increase the effectiveness of troubleshooting. The freeze-frame data display items are given below.

Item No.	Data		Unit
12	Air flow sensor		g/sec
13	Intake air temperature sensor		°C
21	Engine coolant temperature sensor		°C
22	Crank angle sensor		r/min
24	Vehicle speed signal		km/h
44	Ignition advance		deg
79	Throttle position sensor (main)		mV
81	Long-term fuel compensation		%
82	Short-term fuel compensation		%
87	Calculated load value		%
88	Fuel control condition	Open loop	OL
		Closed loop	CL
		Open loop owing to drive condition	OL-DRV
		Open loop owing to system malfunction	OL-SYS
89	Fuel control condition		–

DIAGNOSIS CODE

The diagnosis and engine warning lamp items are given in the table below.

Code No.	Diagnosis item	Main diagnosis contents	Engine warning lamp
P0011	Variable valve timing system	Abnormal oil passage in variable valve timing system	–
P0090	Fuel pressure control solenoid valve system	Open circuit or short-circuit in solenoid valve-related circuit	ON
P0100	Air flow sensor system	Open circuit or short-circuit in valve-related circuits	ON
P0105	Barometric pressure sensor system	Open circuit or short-circuit in sensor-related circuits	ON
P0110	Intake air temperature sensor system	Open circuit or short-circuit in sensor-related circuits	ON
P0115	Engine coolant temperature sensor system	Open circuit or short-circuit in sensor-related circuits	ON
P0122	Throttle position sensor (main) circuit low input	Open circuit or short-circuit in sensor-related circuits	ON

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Code No.	Diagnosis item	Main diagnosis contents	Engine warning lamp
P0123	Throttle position sensor (main) circuit high input	Short-circuit in sensor-related circuits	ON
P0125	Feedback system monitor	Oxygen sensor not operating	ON
P0130	Oxygen sensor system	Open circuit or short-circuit in sensor-related circuits	ON
P0135	Oxygen sensor heater system	Open circuit or short-circuit in heater-related circuits	ON
P0136	Oxygen sensor (rear) system	Open circuit or short-circuit in sensor-related circuits	ON
P0141	Oxygen sensor heater (rear) system	Open circuit or short-circuit in heater-related circuits	ON
P0170	Abnormal fuel system	Leanness or richness problem	ON
P0201	No. 1 injector system	Open circuit or short-circuit in injector-related circuits	ON
P0202	No. 2 injector system	Open circuit or short-circuit in injector-related circuits	ON
P0203	No. 3 injector system	Open circuit or short-circuit in injector-related circuits	ON
P0204	No. 4 injector system	Open circuit or short-circuit in injector-related circuits	ON
P0222	Throttle position sensor (sub) circuit low input	Open circuit or short-circuit in sensor-related circuits	ON
P0223	Throttle position sensor (sub) circuit high input	Open circuit in sensor-related circuits	ON
P0243	Abnormal waste gate system	Abnormal in waste gate solenoid valve	–
P0300	Random cylinder misfire detection system	Abnormal ignition signal (Misfiring)	ON
P0301	No. 1 cylinder misfire detection system	Misfiring	ON
P0302	No. 2 cylinder misfire detection system	Misfiring	ON
P0303	No. 3 cylinder misfire detection system	Misfiring	ON
P0304	No. 4 cylinder misfire detection system	Misfiring	ON
P0325	Detonation sensor system	Abnormal sensor output	ON
P0335	Crank angle sensor system	Abnormal sensor output	ON
P0340	Camshaft position sensor system	Abnormal sensor output	ON
P0421	Catalyst malfunction	Abnormal exhaust gas purification performance of catalyst	ON
P0443	Purge control solenoid valve system	Open circuit or short-circuit in solenoid valve-related circuits	ON

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Code No.	Diagnosis item	Main diagnosis contents	Engine warning lamp
P0500	Vehicle speed sensor system	Open circuit or short-circuit in sensor-related circuits	ON
P0513	Immobilizer malfunction	Open circuit or short-circuit in sensor-related circuits	–
P0603	EEPROM malfunction	Abnormality in engine-ECU	–
P0606	Engine-ECU main processor malfunction	Abnormality in engine-ECU	ON
P0622	Alternator FR terminal system	Open circuit or short-circuit in system-related circuits	–
P0638	Throttle valve control servo circuit range/performance problem	Abnormal throttle valve control servo	ON
P0642	Throttle position sensor power supply malfunction	Open circuit or short-circuit in sensor-related circuits	ON
P0657	Throttle valve control servo relay circuit malfunction	Open circuit or short-circuit in sensor-related circuits	ON
P1021	Oil feeder control valve system	Open circuit and short-circuit in solenoid valve-related circuits	–
P1231	Trustful check active stability control (ASC)	ABS/ASC-ECU	–
P1233	Trustful check throttle position sensor (main)	Abnormality in throttle position sensor (main)	ON
P1234	Trustful check throttle position sensor (sub)	Abnormality in throttle position sensor (sub)	ON
P1235	Trustful check air flow sensor	Abnormality in air flow sensor	ON
P1236	A/D converter system	Abnormality in engine-ECU	ON
P1237	Trustful check accelerator pedal position sensor	Abnormality in accelerator pedal position sensor	ON
P1238	Air flow sensor trustful for torque monitoring	Abnormality in engine-ECU	ON
P1239	Trustful check engine speed	Abnormality in engine-ECU	ON
P1240	Trustful check ignition angle	Abnormality in ABS/ASC-ECU	–
P1241	Torque monitoring	Abnormality in engine-ECU	ON
P1602	Communication malfunction (between engine-ECU main processor and system LSI)	Abnormality in engine-ECU	ON
P1603	Battery back-up circuit malfunction	Open circuit or short-circuit in system-related circuits	ON
P2100	Throttle valve control servo circuit (open)	Open circuit in throttle valve control servo-related circuit	ON
P2101	Throttle valve control servo magneto malfunction	Short-circuit in system-related circuits	ON
P2108	Throttle valve control servo processor malfunction	Abnormality in engine-CVT-ECU	ON

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Code No.	Diagnosis item	Main diagnosis contents	Engine warning lamp
P2122	Accelerator pedal position sensor (main) circuit low input	Open circuit or short-circuit in sensor-related circuits	ON
P2123	Accelerator pedal position sensor (main) circuit high input	Open circuit in sensor-related circuits	ON
P2127	Accelerator pedal position sensor (sub) circuit low input	Open circuit or short-circuit in sensor-related circuits	ON
P2128	Accelerator pedal position sensor (sub) circuit high input	Open circuit in sensor-related circuits	ON
P2135	Throttle position sensor (main and sub) range/performance problem	Abnormal sensor output	ON
P2138	Accelerator pedal position sensor (main and sub) range/performance problem	Abnormal sensor output	ON
U1073	Bus off	Abnormality in CAN bus line	–
U1102	ASC-ECU time-out	Abnormality in CAN bus line	–
U1106	EPS-ECU time-out	Abnormality in CAN bus line	–
U1108	Combination meter time-out	Abnormality in CAN bus line	–
U1110	A/C-ECU time-out	Abnormality in CAN bus line	–

DATA LIST FUNCTION

The data list items are given in the table below

Item No.	Inspection item	Unit
11	Oxygen sensor	mV
12	Air flow sensor	g/s
13	Intake air temperature sensor	°C
14	Throttle position sensor (sub)	mV
16	Power supply voltage	V
18	Cranking signal (ignition switch-ST)	ON/OFF
21	Engine coolant temperature sensor	°C
22	Crank angle sensor	r/min
25	Barometric pressure sensor	kPa
29	Inhibitor switch	P or N/D, 2, L, or R
37	Volumetric efficiency	%
41	Injectors	ms
44	Ignition advance	°BTDC
49	A/C relay	ON/OFF
67	Stop lamp switch	ON/OFF
77	Accelerator pedal position sensor (sub)	mV
78	Accelerator pedal position sensor (main)	mV
79	Throttle position sensor (main)	mV
7E	Variable valve timing phase angle	°CA

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Item No.	Inspection item	Unit
12*	Air flow sensor	gm/s
13*	Intake air temperature sensor	°C
21*	Engine coolant temperature sensor	°C
22*	Crank angle sensor	r/min
24*	Vehicle speed	km/h
44*	Ignition advance	deg
8A*	Throttle position sensor (main)	%
A1*	Oxygen sensor	V

NOTE: Items marked "" will not appear if a data list is selected in the check mode.*

ACTUATOR TEST FUNCTION

The actuator test items are given in the table below

Item No.	Inspection item	Drive contents
01	Injectors	Cut fuel to No.1 injector
02		Cut fuel to No.2 injector
03		Cut fuel to No.3 injector
04		Cut fuel to No.4 injector
07	Fuel pump	Fuel pump operates and fuel is recirculated
08	Purge control solenoid valve	Solenoid valve turns from OFF to ON
12	Waste gate solenoid valve	Solenoid valve turns from OFF to ON
17	Basic ignition timing	Set to ignition adjustment mode
20	Cooling fan control relay (high speed)	Drive the fan motor at high speed
21	Cooling fan control relay (low speed)	Drive the fan motor at low speed
34	Throttle valve control servo	Stop the throttle valve control servo

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Engine-ECU Monitor Item

- Items useful for grasping the engine control condition by the engine-ECU are provided in this monitor item section.
- Values of these monitor items vary greatly depending on marginal difference of measurement conditions, difference of the environment, aged deterioration of vehicles and so on, and it is difficult to show the precise specification values. Therefore, check conditions, display range and movement of values are described.

Item No.	Inspection item	Display range, numerical value
5A	Air-fuel ratio learning value of B zone (Low speed load)	–25 to 25%
5B	Idle speed control position learned value	–128 to 127STEP
5C	Idle speed control position learned value (A/C load)	–128 to 127STEP
6A	Knock retard	Retards in response to accelerator opening
6B	Learned knock retard	0 – 100%
6C	Target Idle speed	Changes in response to engine coolant temperature
9B	Air-fuel ratio learning value of A zone (Low speed load)	–25 to 25%
9D	Air-fuel ratio feedback integration	–25 to 25%
B1	Waste gate solenoid valve duty	0 – 100%
B2	Alternator G terminal duty	Increases
B3	Purge control solenoid valve duty	0 – 100%
81*	Long-term fuel compensation	–25 to 25%
82*	Short-term fuel compensation	–25 to 25%
87*	Calculation load value	0 – 100%
88*	Fuel control condition	Changes depending on driving condition

*NOTE: *: This item is not displayed when the data list in check mode is selected.*